

Application for United States Patent

of

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for

“An Improved Wall and Partition Construction and Method Including
a Laterally Adjustable Flanged Stud”

CROSS-REFERENCE TO RELATED APPLICATIONS

(CLAIMING BENEFIT UNDER 35 U.S.C. 120)

This application is related to U.S. patent application, serial number 10,715,258,
docket number ABS2003-003, filed on November 17, 2003, by John Parker Burg.

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FEDERALLY SPONSORED RESEARCH
AND DEVELOPMENT STATEMENT

This invention was not developed in conjunction with any Federally sponsored
contract.

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MICROFICHE APPENDIX

Not applicable.

INCORPORATION BY REFERENCE

This application is incorporated by reference related patent application, serial number 10,715,258 in its entirety.

BACKGROUND OF THE INVENTION

[0001] The fitting-out of occupiable space is continuously becoming more important
5 and ever more challenging for those utilizing modern office buildings, business and
conference centers, hotels, classrooms, medical facilities, and the like. In the
competitive business environment, cost concerns alone often dictate the efficient use of
interior space. Thus, the finishing or fitting-out of building spaces for offices and other
areas where work is conducted has become a very important aspect of effective space
10 planning and layout.

[0002] Business organizations, their work patterns and the technology utilized therein
are constantly evolving and changing. Building space users require products that provide
for change at minimal cost. At the same time, their need for functional interior
accommodations remains steadfast. Issues of privacy, functionality, aesthetics, acoustics,
15 etc., are unwavering. For architects and designers, space planning for both the short and
long term is a dynamic and increasingly challenging problem. Changing work processes
and the technology required demand that designs and installation be able to support and
anticipate change.

[0003] Space allocation and planning challenges are largely driven by the fact that
20 modern office spaces are becoming increasingly more complicated due to changing and
increasing needs of users for more and improved utilities support at each workstation or

work setting. These utilities encompass all types of resources that may be used to support or service a worker, such as communications and data used with computers and other types of data processors, telecommunications, electronic displays, etc., electrical power, conditioned water, and physical accommodations, such as lighting, HVAC, sprinklers, security, sound masking, and the like. For example, modern offices for highly skilled "knowledge workers" such as engineers, accountants, stock brokers, computer programmers, etc., are typically provided with multiple pieces of very specialized computer and communications equipment that are capable of processing information from numerous local and remote data resources to assist in solving complex problems.

Such equipment has very stringent power and signal requirements, and must quickly and efficiently interface with related equipment at both adjacent and remote locations. Work areas with readily controllable lighting, HVAC, sound masking, and other physical support systems, are also highly desirable to maximize worker creativity and productivity. Many other types of high technology equipment and facilities are also presently being developed which will need to be accommodated in the work places of the future.

Moreover, the office space layout of these "knowledge workers" changes frequently to accommodate new technology, or to accommodate changing work teams resulting from changing business objectives, changing corporate cultures, or a combination thereof.

[0004] Office workers today need flexible alternative products that provide for the obtainment of numerous, often seemingly conflicting objectives. For example, the cultural aims of an organization may require the creation of both individual and

collaborative spaces, while providing a "sense of place" for the users, and providing a competitive edge for the developer. Their needs include a range of privacy options, from fully enclosed offices which support individual creative work to open spaces for collaborative team work. At the same time, their products must be able to accommodate

5 diverse organizations, unique layout designs, and dynamic work processes.

[0005] Further compounding the challenge are the overall objectives to promote productivity, minimize the expenses of absenteeism and workforce health insurance, and reduce potential liability. Meeting these objectives often requires improved lighting, better air quality, life safety, and ergonomic task support.

10 [0006] As previously mentioned, the cost efficient use of building floor space is also an ever-growing concern, particularly as building costs continue to escalate. Open office plans that reduce overall office costs are commonplace, and generally incorporate large, open floor spaces. These spaces are often equipped with modular furniture systems that are readily reconfigurable to accommodate the ever-changing needs of specific users, as

15 well as the divergent requirements of different tenants. However, for privacy, productivity, or other reasons, interior walls and/or partitions are still required although the functionality requirements of interior walls is changing.

[0007] Historically, office walls or partitions are made by erecting a wood frame comprising vertical studs spaced on a regular interval, lining each side with gypsum board

20 (sheet rock) panels, then finishing the wall surfaces with a variety of textures and paint. When additional thermal and/or acoustic insulation is needed, insulation medium such as

fiberglass, rock wool or mineral wool will commonly be placed to fill the interior space between vertical studs and gypsum board panels.

[0008] These conventional walls have proven sturdy, provide adequate privacy and sound proofing, and provide a surface that easily accepts wall hangings such as pictures, paintings, plaques and the like. Furthermore, as is commonly known, conventional walls

5 can easily be repainted, retextured, and readily patched and repaired when damaged.

Conventional gypsum board partitions are typically custom built floor-to-ceiling installations that, due primarily to the vertical studs, are time-consuming to erect and build. The increased need for utility wiring, such as power and communication cables,

10 have made conventional vertical stud-based walls more cumbersome and inconvenient as horizontal paths for the utility wiring must be routed either through numerous vertical studs or up and into a ceiling passage or plenum, then back down and to the end location.

[0009] As stated, interior walls in offices, hotels and the like are typically made by erecting a frame that includes vertical studs, either wood or steel, on a 16" or 24" spacing,

15 lining each side with gypsum board (sheet rock) panels, then finishing the wall surfaces with a variety of textures and paint. FIGS. 1a - 1d illustrate a cross-sectional top-down view of such constructions.

[0010] FIG. 1a shows a wall construction 100 comprised of vertical 2x4 studs 102 lined on each side by 5/8" gypsum board 101 with empty space 103 therebetween. FIG. 1b

20 shows a wall construction 200 comprised of vertical 2x4 studs 202 lined on each side by 5/8" gypsum board 201 with insulation 203 filling the interior space.

[0011] FIG. 1c shows a wall construction 300 comprised of 3 ½" vertical steel studs 302 lined on each side by 5/8" gypsum board 301. FIG. 1d shows a wall construction 400 comprised of 3 ½" vertical steel studs 402 lined on each side by 5/8" gypsum board 401 with insulation 403 filling the interior space.

5 [0012] For the primary objective of increasing the sound attenuating properties of walls, numerous alternative practices have been used. FIGS. 1e - 1g provide top-down cross-sectional views of alternative constructions.

[0013] FIG. 1e shows a wall construction 500 wherein vertical 2x4 studs 502 are placed in a staggered configuration such that no direct rigid connection is made between gypsum
10 board panels 501 lining each wall face. Insulation 503 is used to fill interior spaces.

[0014] FIG. 1f shows a wall construction 600 wherein vertical 2x4 studs 602 are placed in a two-wide configuration effectively doubling the overall wall thickness. Gypsum board 601 lines each face and insulation 603 fills interior spaces.

[0015] FIG. 1g is similar to FIG. 1f except the two-wide 2x4 studs are replaced by 7"
15 steel studs 702 and two layers of gypsum board 701 are used on one side. Insulation 703 is used to fill interior spaces. The wall construction of FIG. 1g, by way of the double layer of gypsum board on one face provides a one hour fire rating as required by many commercial applications such as hotel constructions.

[0016] Based upon the state of the art as described in FIGS. 1a - 1g, a wall construction
20 is needed that effectively utilizes the favorable structural and acoustic properties of superior construction materials, namely compressed straw panels discussed *infra*, and

preferably construction materials made primarily from recovered or otherwise discarded materials. Further, what is needed in the art is a wall construction method that is quicker and more cost effective to install than conventional wall constructions while providing easy routing and re-routing of increasing amounts of utility wiring and communication

5 cables. Still further, what is needed in the art is a wall construction method that provides the flexibility and reconfigurability of currently available partial or full height partition systems while providing the sturdiness, sound attenuation and ease of resurfacing provided by conventional gypsum board walls. Finally, what is needed in the art is a wall construction that contains no exterior connectors such as nails, screws, and the like that

10 require additional surface treatment to finish.

[0017] The current applicant's invention disclosed in pending U.S. patent application no. 10/715,258 provides a wall construction system that meets these stated needs of the art, while providing a system made primarily of recycled materials.

[0018] There further exists a need in the art, however, for a wall construction system

15 and method that provides easy lateral movement of vertically oriented hat-channel studs while maintaining alignment along a wall line and which eliminates the need for a rigid attachment between the top and bottom of each hat-channel stud and the ceiling and floor respectively.

SUMMARY OF THE INVENTION

- [0019] The present invention relates to the construction of interior and exterior walls and especially to the finishing or fitting-out of building space such as offices, hotels, conference centers, business centers, meeting rooms, medical facilities, classrooms, etc. Particularly, the present invention provides for the finishing out of open space using a system comprising a series of rails attached along a wall line to a ceiling and floor. Floor and ceiling rails are designed to hold a plurality of vertically oriented hat-channel shaped studs therebetween such that the studs are able to slide laterally along the wall line while being held between said floor and ceiling rails. Studs are laterally spaced at intervals approximately equal to the width of compressed straw building panels to be assembled thereon, but remain laterally moveable to provide for lateral adjustment as wall assembly proceeds. Compressed straw panels are attached to the studs in a specific systematic manner resulting a wall or partition that includes no exterior penetrations or connectors.
- [0020] The result is a relatively seamless exterior surface that can be finished in a plurality of ways, but one that, if desired, can be utilized with minimal surface treatment. The finished wall is structurally strong, but substantially hollow, thus enabling very easy routing and re-routing of utility wiring there through. Said studs are provided with a plurality of horizontal opening through which utility wiring and communication cabling can easily be routed. Assembly is simple, fast and inexpensive relative to the construction of conventional interior walls primarily due to significant potential savings

in labor costs. The features and advantages of the present invention will be further understood and appreciated by those skilled in the art by reference to the following written specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The present invention should be more fully understood when the written description is considered in conjunction with the drawings contained herein, wherein:

5 [0022] FIGS. 1a-1g, provide illustrations of known wall construction methods.

FIG. 2 shows an isometric view of our sliding flanged stud and the associated floor and ceiling rails;

[0023] FIG. 3a shows an isometric detailed view of our sliding flanged stud ;

[0024] FIG. 3b shows an isometric detailed view of our floor and ceiling rail;

10 [0025] FIG. 4a shows an isometric view of our assembly comprising first and second sliding flanged studs properly positioned and held between a floor and ceiling rail;

[0026] FIG. 4b shows a side view of our assembly comprising first and second sliding flanged studs properly positioned and held between a floor and ceiling rail;

[0027] FIG. 5a shows an isometric sectional view of the assembly shown in FIG. 4;

15 [0028] FIG. 5b shows the assembly of FIG. 5a with a first strawboard panel attached;

[0029] FIG. 5c shows the assembly of FIG. 5b with a second strawboard panel attached;

[0030] FIG. 5d shows the assembly of FIG. 5c with a third strawboard panel positioned and illustrates the lateral adjustment of second sliding flanged stud ;

[0031] FIG. 5e shows the assembly of FIG. 5d with a third strawboard panel attached;

20 [0032] FIG. 5f shows the assembly of FIG. 5e with a fourth strawboard panel attached;

[0033] FIG. 6 provides a top-down sectional detail of the connection between strawboard panels and flanged stud;

[0034] FIG. 7 provides an isometric view of two alternative embodiments of floor rail, ceiling rail and flanged stud;

- 5 **[0035]** FIGS. 8a and 8b provide isometric views of a third alternative embodiment of flanged stud; and

[0036] FIG. 9a and 9b provide a side view and installation details of a third alternative embodiment of flanged stud.

DETAILED DESCRIPTION OF THE INVENTION

[0037] Though most of the background discussion, *supra*, implies an interior application, said construction is well suited for exterior wall constructions as well. In exterior applications, the hollow interior space may be used to contain supplemental thermal and/or acoustic insulation. Further, said compressed straw panels are well suited for accepting a variety of weather proof panels, coatings, or the like attached thereto.

[0038] The present invention preferably utilizes solid core compressed straw or strawboard panels comprised of a matrix of highly compressed straw, usually wheat, rice or other recovered agricultural straw, lined on all sides by paper or paperboard. Typically, the strawboard panels are made through a dry extrusion process wherein straw is compressed into a substantially flat continuous web, normally between 1½" and 3½" thick and between 40" and 60" wide. The continuous web is then cut into rectangular panels of various lengths. Panel length is easily varied. The compressed straw is arranged in layers with the straw fibers substantially parallel in orientation extending transversely across the strawboard panel from side to side when the strawboard panel is in a normal in-use orientation. Said strawboard panels are typically rectangular in shape, and for the purposes of this disclosure, will be oriented such that the longer edges are substantially vertical and the shorter edges are substantially horizontal. In this orientation, said straw fibers will assume a generally horizontal orientation. Said strawboard panels have a tackable surface, i.e., are suitable for securely accepting nails,

tacks, screws and other connecting means for attaching and/or hanging items from the strawboard panel surfaces.

[0039] Further, surfaces of the strawboard panels are suitable for accepting surface texture, paint, wall paper, and other conventional wall coverings. Strawboard panels can be factory finished with surface texture, paint, wall paper and the like, or said surface treatments can easily be applied to a finished wall. Compressed strawboard panels are typically much thicker and stronger than gypsum board and possess higher nail pull values, thus providing nails, screws, or the like driven therein to support more weight than if driven into gypsum board. Additionally, said strawboard panels possess sound
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10 insulating properties superior to both conventional gypsum board walls and many currently available commercial interior partition systems.

[0040] Solid core strawboard panels further provide fire resistant properties superior to materials used in many presently available interior wall construction and partition systems. To enhance flexibility, these strawboard panels can be cut and formed in the
15 field using conventional tools such as circular, saber or band saws, routers, drywall hand saws, utility knives and the like. Ideally, however, the wall will be designed so that field alteration of said strawboard panels is minimized, thus minimizing installation time and costs. In the preferred embodiment, strawboard panels manufactured by Affordable Building Systems of Texas are used.

[0041] Referring first to FIG. 3a, a detailed isometric view of our flanged stud 5 is
20 provided and is shown to comprise a large flange 10 and a small flange 11 in a

substantially co-planar position and disposed about a spine channel 12., said spine channel 12 comprising the entire portion of flanged stud 5 except large flange 10 and small flange 11. As illustrated, each spine channel 12 is provided with a pair of laterally disposed rail guides 15 at each end. Both large flange 10 and small flange 11 are
5 provided with a plurality of lag screw receivers 13 for accepting the shaft of a properly sized lag screw therein.

[0042] The relative dimensions of large flange 10, small flange 11 and spine channel 12 are variable and can be changed to meet specific criteria such as wall depth. It should be noted that throughout this disclosure flanged stud 5 is shown as having a large flange 10
10 and a small flange 11. This size differentiation is done largely for descriptive purposes, and said flanges can alternatively be the same size.

[0043] Flanged stud 5 is preferably made from 16 gauge steel, but alternately can be made from any material, metal or non-metal, that provides comparable strength and stiffness and preferably a comparable or higher melting temperature (~2500° F).

15 [0044] FIG. 3b provides a detailed isometric view of ceiling rail 7 and floor rail 8, each comprised of a first flange 16, and second flange 17, and a raised channel 18 disposed between said flanges. Said first flange 16 and second flange 17 are each preferably provided with a plurality of lag screw receivers 13 for accepting the shaft of a properly sized lag screw therein. It can be seen that ceiling rail 7 and floor rail 8 are identical
20 pieces in opposite orientation and can be used interchangeably in a preferred embodiment. Both floor rail 8 and ceiling rail 7 are preferably made from 16 gauge steel,

but can be made from any material, metal or non-metal, that provides comparable strength and stiffness and a comparable or higher melting temperature (~2500° F). The actual gauge needed will depend upon the specific application and may be heavier or lighter than 16 gauge.

- 5 **[0045]** FIG. 2 provides an isometric view of an assembly of a flanged stud 5 positioned between a floor rail 8 and a ceiling rail 7. Flanged stud 5 is preferably provided with a utility opening 14 that allows for the routing of utilities such as power wiring and communication cables through the interior of a finished wall. Typically, each flanged stud 5 is provided with a plurality of utility openings 14. FIG. 2 specifically illustrates
- 10 the interaction between said rail guides 15 and raised channels 18. Each rail guide 15 and raised channel 18 is designed and sized to provide component interaction that allows flanged stud 5 to slide laterally in a plane defined by the lateral center lines of opposed floor rail 8 and ceiling rail 7, while preventing flanged stud 5 from moving out of said plane. Said plane then defines the centerline of the finished wall.
- 15 **[0046]** FIG. 2 further illustrates that the first flange 16 and second flange 17 of both the floor rail 8 and ceiling rail 7 are preferably sized so as to make a flush fit along the end of flanged stud 5 when each components are assembled. Each rail guide 15 is preferably sized to provide a horizontal clearance of approximately 1/4" between said rail guide 15 and each raised channel 18 properly positioned there through.
- 20 **[0047]** FIGS. 4a and 4b, respectively, provide isometric and side views of our new wall frame assembly comprising floor rail 8, ceiling rail 7 and a first flanged stud 5 and second

flanged stud 6 properly disposed therebetween.

[0048] FIG. 4a further provides a view of first flanged stud 5 and second flanged stud 6 each provided with a plurality of utility openings 14.

[0049] FIG. 4b illustrates the contact and implied connection between floor rail 8 and
5 floor 24 and between ceiling rail 7 and ceiling 23. The respective connections between floor rail 8 and floor 24 and between ceiling rail 7 and ceiling 23 can be made by an number of suitable means such as screws, nails, bolts, anchor bolts, adhesive, etc.,. When an installation requires ceiling rail 7 to be attached to runner of a suspended ceiling or the like, a clip connection or the like may be used in place of screws or adhesive.

10 [0050] The step by step assembly of a wall according to the present invention is illustrated in FIGS. 5a - 5f which provide isometric sectional views of our wall assembly as it is being assembled. Note that the views provided in FIGS. 5a - 5f are sectional views, and the ceiling rail 7 as well as top of first and second flanged stud 5, 6 and the top of each strawboard panel 1,2,3,4 are not shown.

15 [0051] In FIG. 5a, floor rail 8, first flanged stud 5, and second flanged stud 6 are shown in assembled form. It can be seen that both first and second flanged studs 5, 6 are preferably provided with a plurality of utility openings 14 and lag screw receivers 13. The designed fit of raised channel 18 and rail guide 15 can also be seen. As previously stated, in the assembled form, i.e., a flanged stud is positioned between ceiling rail and a
20 floor rail with raised channels residing in rail guides at both ends, said stud will be moveable laterally along a plane defined by the opposed ceiling and floor rails.

[0052] In FIG. 5b a first strawboard panel 1 is shown positioned in substantially co-planar relation to the wall centerline and adjacent to the large flange 10 on first flanged stud 5. Though not shown, first strawboard panel 1 is rigidly attached to said large flange 10 by means of screws, nails, or other penetrating connectors. In the preferred embodiment, said rigid attachment is made by means of 1½" lag screws.

[0053] Referring to FIG. 6 which provides a top-down cutaway view of preferred strawboard panel-stud connections, the connection between first strawboard panel 1 and large flange 10 is shown. Attachment is made by means of a plurality of 1½" lag screws 9 inserted through lag screw receivers 13 (not shown) and penetrating first strawboard panel 1. Further, it is important that first strawboard panel 1 does not completely cover the outer face of large flange 10 so as to provide room for third strawboard panel 3 to contact a portion of large flange 10 when in abutted edge-to-edge relation to first strawboard panel 1. Throughout this disclosure, lag screws are used for illustration and are the connector of choice, but nails or other suitable penetrating connectors may be used. Lag screws provide for easy disassembly of a wall with minimal damage to strawboard panels.

[0054] FIG. 5c shows second strawboard panel 2 positioned in co-planar relation to first strawboard panel 1 and positioned adjacent to the outer face of spine channel 12. A plurality of disc connectors 19 can be seen protruding from the edge of second strawboard panel 2. Said disc connectors, disclosed in U.S. Patent 6,634,077 and pending U.S. application no. 10/387,994 are preferably inserted in fitted receivers (not shown). FIG. 6

provides illustration of the arrangement between second strawboard panel 2 and spine channel 12 including rigid connection by means of a plurality of lag screws 9 inserted through lag screw receivers 13 (not shown) and penetrating second strawboard panel 2 to provide a rigid attachment thereto. It is important to point out here that second

5 strawboard panel 2 preferably does not completely cover the outer face of spine channel 12 so as to leave room for a portion of fourth strawboard panel 4. FIG. 6 also illustrates the connection between second strawboard panel 2 and fourth strawboard panel 4 by means of a plurality of disc connectors 19.

[0055] FIG. 5d shows third strawboard panel 3 properly positioned in co-planar and
10 abutted edge to edge relation with first strawboard panel 1 and secured to small flange 11 of first flanged stud 5 by means of lag screws 9. A primary feature of this invention is illustrated by the large inward-facing arrow adjacent to second flanged stud 6, said arrow indicating that second flanged stud 6 can be laterally moved along floor rail 8 and ceiling rail 9 (not shown) into proper position for accepting connection to third strawboard panel
15 3. FIG. 5e then shows second flanged stud 6 in the desired lateral position for connection to third strawboard panel 3. As with the other strawboard panels, the connection between third strawboard panel 3 and second flanged stud 6 is preferably achieved by means of a plurality of 1½" lag screws inserted through lag screw receivers and secured within said third strawboard panel 3.

20 [0056] FIG. 5f shows fourth strawboard panel 4 properly placed in co-planar and abutted edge to edge relation to second strawboard panel 2. A connection between fourth

strawboard panel 4 and second flanged stud 6 is made by via a plurality of lag screws 9 positioned through lag screw receivers 13 located on the outer face of spine channel 12 of second flanged stud 6. Connection between fourth strawboard panel 4 and second flanged stud 6 as well as the connection between second strawboard panel 2 and fourth strawboard panel 4 are illustrated in FIG. 6. The connection between second strawboard panel 2 and fourth strawboard panel 4 is preferably achieved by means of a plurality of disc connectors 19 positioned within connector receivers located in the facing edges of second strawboard panel 2 and fourth strawboard panel 4.

[0057] FIGS. 7a and 7b illustrate alternative embodiments of the ceiling rail 7, floor rail 8 (not shown), and flanged stud 5. FIG. 7a illustrates an alternative ceiling rail 7a which contains two raised flanges 18a in lieu of raised channel 18 (not shown). Further, rail guides 15 (not shown) are replaced by two receiving slits (18a) positioned on the end of alternate flanged stud 5a such that raised flanges 18a can be slidably received therein. Also on flanges stud 5a, utility opening 14 has been replaced by a non-rectangular alternate utility opening 14a.

[0058] FIG. 7b illustrates a second alternative ceiling rail 7b comprising a raised channel 18b with a substantially triangular cross section in lieu of the substantially rectangular shape in the preferred embodiment. Alternative rail guides 15b located on the end of flanged stud 5b are comparably shaped to slidably receive raised channel 18b therein. Alternative utility openings 14b are provided as small group of circular openings.

[0059] FIGS. 7a and 7b illustrate only the top portions of alternative flanged stud 5a and 5b, as well as only associated ceiling rails 7a and 7b, but it should be noted that for both alternative embodiments, as with the preferred embodiment, the ceiling and floor rails can be identical components and the rail guides provided on each end of flanges studs can be identical. Thus, FIGS. 7a and 7b effectively illustrate both the ceiling and floor rails as well as the rail guides located at both ends of each flanged stud.

[0060] FIGS. 8a and 8b illustrate additional alternative embodiments of flanged stud 5. In both FIG. 8a and FIG. 8b anchor tab 25 is illustrated. Said anchor tab 25 is included to provide a convenient means for providing a secure attachment between the top of flanged stud 5 and ceiling rail 7 and between the bottom of flanged stud 5 and floor rail 8. This feature allows for the flexibility of placing a flanged stud 5 in a predetermined position between ceiling rail 7 and floor rail 8, then securing the stud in place by means of self-tapping screw 26 or comparable attachment means placed through said anchor tab 25 and secured to raised channel 18 portion of each ceiling rail 7 and floor rail 8. Also illustrated in FIG. 8a and FIG. 8b, the ends of large flange 10 and small flange 11 each have been tapered 27 with said taper 27 increasing from center to edge. As illustrated in FIG. 9a and 9b, said taper 27 provides for the placement of a flanged stud 5 in between a floor rail 8 and ceiling rail 7 by means of in-place lateral rotation after said stud has been properly positioned.

[0061] As noted *supra*, each rail guide 15 is preferably sized to provide a horizontal clearance between said rail guide 15 and horizontal edge of raised channel 18 portion of

each floor rail 8 and ceiling rail 7. Said horizontal clearance and flange taper 27 provide for an unencumbered in-place lateral rotation of flanged stud 5.

[0062] The embodiments which have been shown and described are exemplary. Even though numerous characteristics and advantages of the present invention have been
5 described in the drawings and accompanying text, the description is illustrative only, and changes may be made in the detail, especially in matters of shape, size, and arrangement of the parts without departing from the scope of the present invention.